**3GPP TSG RAN WG1 #106bis-e R1-21xxxxx**

**e-Meeting, October 11th – 19th, 2021**

**Agenda Item: 8.8**

**Source: Moderator (China Telecom, Sharp, Nokia, Qualcomm, ZTE)**

**Title: [106bis-e-R17-RRC-CovEnh] Email discussion on Rel-17 RRC parameters for Coverage Enhancement**

**Document for: Discussion**

1. Introduction

There was an initial email discussion on RRC parameters for NR coverage enhancements [1]. This contribution is a summary of the following email discussion:

[106bis-e-R17-RRC-CovEnh] Email discussion on Rel-17 RRC parameters for Coverage Enhancement

* 1st check point: October 14
* Final check point: October 19

1. Discussion on RRC parameters for AI 8.8.1.1
2. Discussion on RRC parameters for AI 8.8.1.2
3. Discussion on RRC parameters for AI 8.8.1.3

Table 4.1 RRC parameters for AI 8.8.1.3 from [1]

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| **WI code** | **Sub-feature group** | **RAN2 Parent IE** | **Parameter name in the spec** | **New or existing?** | **Description** | **Value range** | **UE-specific or Cell-specific** | **Specification** | **Comment** |
| NR\_cov\_enh-Core | DM-RS bundling for PUSCH |  | *~~PUSCH-TimeDomainWindow-r17~~* [*PUSCH-DMRS-Bundling*] | new | Enabling/disabling of DM-RS bundling and time domain window for PUSCH. | ENUMERATED {enabled, disable } | [UE-specific] | 38.331 | Agreement • Joint channel estimation for PUSCH transmissions and the time domain window are jointly enabled or disabled via RRC configuration for a UE. o Note: Enabling/disabling of joint channel estimation for PUSCH transmissions means enabling/disabling of DMRS bundling for PUSCH transmissions under the condition of power consistency and phase continuity. |
| NR\_cov\_enh-Core | DM-RS bundling for PUSCH | [PUSCH-Config] | *PUSCH-TimeDomainWindowLength* | new | [Enabling/disabling of DM-RS bundling and time domain window for PUSCH.] Length of a configured time domain window in slots for DMRS bundling for PUSCH. | FFS | [UE-specific] | 38.331 | Working assumption For joint channel estimation for PUSCH repetition type A of PUSCH repetitions of the same TB, all the repetitions are covered by one or multiple consecutive/non-consecutive configured TDWs.  Each configured TDW consists of one or multiple consecutive physical slots.  The window length L of the configured TDW(s) can be explicitly configured with a single value |

R1-2108847 has the following proposal.

Proposal: Only introduce one IE (i.e. *PUSCH-TimeDomainWindowLength*) to indicate both the enabling of JCE and the length of configured TDW for JCE of PUSCH transmissions.

R1-2108991 proposes the followings.

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| **Parameter Name** | **RAN1 spec/ section** | **Values range** | **New R17 vs extension of R15/16** | **Per (UE, cell, TRP, …)** | **Broadcast/**  **dedicated** | **Description** | **RAN2 spec** |
| PUSCH-DMRS-Bundling | 38.214 | ENUMERATED {enabled, disable } | New | Per UE | dedicated | Enabling/disabling of DM-RS bundling and TDW for PUSCH | 38.331 |
| PUSCH-TimeDomainWindowLength | 38.214 | INTEGER(2,3, … , the maximum duration) | New | Per UE | dedicated | Length of a configured TDW in slots for DMRS bundling for PUSCH. | 38.331 |

R1-2109509 has the following proposal.

Proposal 3: Introduce one parameter to indicate enabling of DM-RS bundling and TDW length, with value range same as *numberOfRepetitions-r17*. For example, {2, 3, 4, 7, 8, 12, 16, 20, 24, 28, 32}.

R1-2110002 has the following proposal.

Proposal: Two RRC parameters for enabling/disabling of DMRS bundling and the window length L should be separately configured.

R1-2110124 proposes a new RRC parameter should be defined for when UE restarts a PUCSH bundling window.

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| **Sub-feature group** | **RAN2 Parent IE** | **Parameter name in the spec** | **Description** | **Value range** |
| DM-RS bundling for PUSCH |  | ~~[~~*PUSCH-DMRS-Bundling*~~]~~ | Enabling/disabling of DM-RS bundling and time domain window for PUSCH. | ENUMERATED {enabled, disable } |
| DM-RS bundling for PUSCH | [PUSCH-Config] | *PUSCH-TimeDomainWindowLength* | ~~[Enabling/disabling of DM-RS bundling and time domain window for PUSCH.]~~ Length of a configured time domain window in slots for DMRS bundling for PUSCH. | FFS |
| DM-RS bundling for PUSCH | [PUSCH-Config] | *PUSCH-Window-Restart* | UE bundles PUSCH DM-RS slots remaining in a bundling window after a slot for which events violate power consistency and phase continuity requirements | ENUMERATED {enabled, disable } |

## 4.1 1st round discussion

**FL comments:** The outcome of [1] can be the starting point for the discussion. Based on the guideline in [2], “RAN2 parent IE” in column E should be moved to column M. RRC parameters for AI 8.8.1.3 is updated in the following table.

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| **WI code** | **Sub-feature group** | **Parameter name in the spec** | **New or existing?** | **Description** | **Value range** | **Per (UE, cell, TRP, …)** | **UE-specific or Cell-specific** | **Specification** | **Comment** |
| NR\_cov\_enh-Core | DM-RS bundling for PUSCH | *~~PUSCH-TimeDomainWindow-r17~~* [*PUSCH-DMRS-Bundling*] | new | Enabling/disabling of DM-RS bundling and time domain window for PUSCH. | ENUMERATED {enabled, disable } |  | [UE-specific] | 38.331 | Agreement • Joint channel estimation for PUSCH transmissions and the time domain window are jointly enabled or disabled via RRC configuration for a UE. o Note: Enabling/disabling of joint channel estimation for PUSCH transmissions means enabling/disabling of DMRS bundling for PUSCH transmissions under the condition of power consistency and phase continuity. |
| NR\_cov\_enh-Core | DM-RS bundling for PUSCH | *PUSCH-TimeDomainWindowLength* | new | [Enabling/disabling of DM-RS bundling and time domain window for PUSCH.] Length of a configured time domain window in slots for DMRS bundling for PUSCH. | FFS | in [PUSCH-Config] | [UE-specific] | 38.331 | Working assumption For joint channel estimation for PUSCH repetition type A of PUSCH repetitions of the same TB, all the repetitions are covered by one or multiple consecutive/non-consecutive configured TDWs.  Each configured TDW consists of one or multiple consecutive physical slots.  The window length L of the configured TDW(s) can be explicitly configured with a single value |

Companies are encouraged to provide comments on RRC parameters for AI 8.8.1.3.

* Whether to introduce two RRC parameters to indicate enabling of DM-RS bundling and the window length of the configured TDW respectively or introduce only one RRC parameter to indicate both of them?
* Whether to introduce a new RRC parameter for when UE restarts a PUCSH bundling window?
* Any other comments?

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| **Companies** | **Comments** |
| QC | Introducing two parameters might help with overall readability. Further, if we make changes to DMRS bundling in the future where we alter the window length or bundling procedure, the enable/disable parameter can be preserved as is.  Don’t see value in introducing an RRC parameter to control restarting of DMRS bundling. |
| Sharp | We prefer to introduce two RRC parameters to indicate enabling of DMRS bundling and window length L respectively. When DMRS bundling is disabled, inter-bundle frequency hopping is effective for e.g., UE multiplexing. In our view, the hopping interval of the inter-bundle frequency hopping is determined as the window length L or based on the window length L.  The new RRC parameter for enabling of restarting DMRS bundling is not needed because whether UE restarts DMRS bundling within the configured TDW can be determined subject to UE capability. |
| CATT | Either one or two parameters scheme will be workable.  If no specific need is foreseen, one parameter (*PUSCH-TimeDomainWindowLength*) mechanism is sufficient and simpler. The absence of this RRC parameter means no DMRS bundling for the UE. |
| Lenovo, Motorola Mobility | In our view, although, single RRC parameter is sufficient to indicate enabling of DM-RS bundling and window length of the configured TDW, but we are also okay to introduce two parameters  RRC parameter for enabling the restart of DMRS bundling is not needed |
| vivo | We did not see strong motivation to have two separated parameters, the configured window length is sufficient. If the configured window length is absent, DMRS bundling is not enabled. |
| ZTE | According to the agreement in RAN1#106-e meeting, joint channel estimation for PUSCH transmissions and the time domain window are jointly enabled or disabled via RRC configuration for a UE. So, only one IE should be sufficient. |
| Intel | Our view is that using a single RRC parameter would be more appropriate to enable DMRS bundling and indicate TDW duration. For instance, if TDW duration is not configured, then DMRS bundling is not enabled and vice versa.  Regarding a new RRC parameter for when UE restarts a PUCSH bundling window, as this is UE capability, we are not sure whether this additional RRC parameter is needed. |
| Samsung | Q1: We are fine with either. If two RRC parameters are introduced to indicate enabling of DM-RS bundling and the window length of the configured TDW, then we should further clarify the case of enabling of DM-RS bundling without the configured window length.  Q2: We don’t think the new RRC parameter is necessary for restarting DM-RS bundling. Our view is that the capability of DM-RS bundling includes DM-RS bundling can be restarted before/after event.  Q3: It is discussed in AI 8.8.2 whether to use one parameter for PUSCH and PUCCH, e.g. DMRS-Bundling, DMRS-WindowLength. The discussions should be harmonized. |
| Ericsson | Q1: We think it is not necessary to always configure a TDW length L, as it may only be needed when the UE’s maximum duration is relatively short. So we think it is better to have two parameters. Regarding the 106-e agreement, joint channel estimation depends on the window, but not on having a configured value of L, so the issue of one or two parameters still needs to be decided.  Q2; The need for a new RRC parameter for when UE restarts a PUCSH bundling window in our view is not driven by the window design, but by how UE capability is managed in the network. We encourage companies to check the LS with guidance on UE capability from RAN2 (R1-2001513), which asks that we avoid defining functionality that has no RRC configuration but is dependent on capability bits. So the UE capability to restart PUSCH DM-RS bundling with a new actual TDW requires us to define a new RRC parameter to control this behavior.  Q3: We think separate parameters for PUCCH and PUSCH make sense and so are happy with the current set of parameters in that sense. |

## 4.2 2nd round discussion

**FL comments:** It seems companies’ views are split. Based on companies’ comments, option 1 may be beneficial for default value and further enhancement in the future. I suggest to take option 1 as an agreement.

* **Option 1:** Introduce two RRC parameters to indicate enabling of DM-RS bundling and the window length of the configured TDW respectively.

Support: Qualcomm, Sharp, CATT, Lenovo, Motorola Mobility, Samsung, Ericsson

* **Option 2:** Introduce only one RRC parameter to indicate enabling of DM-RS bundling and the window length of the configured TDW.

Support: CATT, Lenovo, Motorola Mobility, vivo, ZTE, Intel, Samsung

**Proposal 1:**

* Introduce two RRC parameters to indicate enabling of DM-RS bundling and the window length of the configured TDW respectively.

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| **Companies** | **Comments** |
| Apple | We are ok with both option 1 and option2.  Proposal 1 is fine as well. We are considering maybe we need a new agreement to revert RAN1#106 meeting agreements to avoid confusion. Such as, **the following agreements are replaced by “Introduce two RRC parameters to indicate enabling of DM-RS bundling and the window length of the configured TDW respectively”**  **Agreement**   * Joint channel estimation for PUSCH transmissions and the time domain window are jointly enabled or disabled via RRC configuration for a UE.   + Note: Enabling/disabling of joint channel estimation for PUSCH transmissions means enabling/disabling of DMRS bundling for PUSCH transmissions under the condition of power consistency and phase continuity. |
| NTT DOCOMO | We support Option 2. There is no benefit by introducing two parameters. Only one parameter is sufficient. |
| Intel | We support Option 2. Otherwise we would revert the agreement as mentioned by Apple. |
| QC | Prefer Option 1 and agree with proposal.  It is possible that this feature evolves in future releases. For this reason keeping enabling/disabling separate from window length and other potential parameters is beneficial.  Yes, we are aware of the previous agreement, but don’t see any harm in deviating. No malintent here, just trying to make things more easy to interpret. |
| FL | In my understanding, the agreement states joint channel estimation and TDW are jointly enabled or disabled via RRC configuration, not joint channel estimation and window length are jointly enabled or disabled. If default value of configured TDW is introduced, it does not violate the agreement. |
| Nokia/NSB | We share the FL’s understanding that the above agreement quoted by Apple simply means that JCE and TDW are enabled/disabled together. However, it does not give any implication on how to configure the TDW size L, if any. In this regard, introducing two separate RRC parameters for the two configurations is a cleaner option. We therefore support Option 1 and FL’s proposal. |
| Ericsson | Prefer Option 1. If there is only one parameter, the behavior is more constrained than if there are two. For example, if the UE can support a max duration of 4 in FDD, and the network uses a repetition factor of 2, why would the network need to configure the UE with a window length?  Agree with Nokia and FL that two parameters does not revert the agreement. Joint channel estimation depends on the window, but not on having a configured value of L, so the issue of one or two parameters still needs to be decided. |
| Samsung | We are fine with the proposal. |
| Sharp | Support |

**FL comments:** After checking R1-2001513, which states “Avoid defining functionality that has no RRC configuration but is dependent on capability bits.” It makes sense to introduce a new RRC parameter.

**Proposal 2:**

* Introduce a new RRC parameter for when UE restarts a PUCSH bundling window

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| **Companies** | **Comments** |
| Apple | We are ok to introduce this new parameter, if the related UE capability is agreed. |
| NTT DOCOMO | Support. |
| Intel | We are fine with this. |
| QC | Thanks for the reference to R1-2001513. We are fine with this. |
| Nokia/NSB | Support. |
| Ericsson | Support |
| Samsung | We would need to have an agreement in 8.8.1.3 first, then introduce an RRC parameter. |
| Sharp | Support |

**FL comments:** The list of RRC parameters is updated accordingly.

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| **WI code** | **Sub-feature group** | **Parameter name in the spec** | **New or existing?** | **Description** | **Value range** | **Per (UE, cell, TRP, …)** | **UE-specific or Cell-specific** | **Specification** | **Comment** |
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| NR\_cov\_enh-Core | DM-RS bundling for PUSCH | *PUSCH-TimeDomainWindowLength* | new | Length of a configured time domain window in slots for DMRS bundling for PUSCH. | FFS | in [PUSCH-Config] | [UE-specific] | 38.331 | Working assumption For joint channel estimation for PUSCH repetition type A of PUSCH repetitions of the same TB, all the repetitions are covered by one or multiple consecutive/non-consecutive configured TDWs.  Each configured TDW consists of one or multiple consecutive physical slots.  The window length L of the configured TDW(s) can be explicitly configured with a single value |
| NR\_cov\_enh-Core | DM-RS bundling for PUSCH | *PUSCH-Window-Restart* | new | UE bundles PUSCH DM-RS slots remaining in a bundling window after a slot for which events violate power consistency and phase continuity requirements | ENUMERATED {enabled, disable } | in [PUSCH-Config] | [UE-specific] | 38.331 | Working assumption:  If the power consistency and phase continuity are violated due to an event, whether a new actual TDW is created is subject to UE capability of supporting restarting DMRS bundling.  If UE is capable of restarting DM-RS bundling, one new actual TDW is created after the event,  FFS: The start of the new actual TDW is the first available slot/symbol for PUSCH transmission after the event.  If UE is not capable of restarting DM-RS bundling, no new actual TDW is created until the end of the configured TDW. |

Companies are encouraged to provide further comments on the above update.

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| **Companies** | **Comments** |
| Nokia/NSB | It is unclear what DM-RS slot is. This concept does not exist in NR. For this reason, the wording for the description of *PUSCH-Window-Restart* should be corrected as follows.  “UE bundles PUSCH DM-RS ~~slots~~ symbols remaining in a bundling window after an ~~slot for which~~ event~~s~~ that violates power consistency and phase continuity requirements” |
| Ericsson | The details of how DMRS are bundled should be debated in the main thread of 8.8.1.3. Perhaps we can generalize to avoid Nokia’s concern, and keep the text as a starting point that we can refine after more progress in 8.8.1.3 by marking it with square brackets:  “[UE bundles PUSCH DM-RS ~~slots~~ remaining in a bundling window after ~~a slot for which~~ event(s) that violate power consistency and phase continuity requirements]” |
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**FL comments:** The list of RRC parameters is updated accordingly.

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| NR\_cov\_enh-Core | DM-RS bundling for PUSCH | *PUSCH-Window-Restart* | new | [UE bundles PUSCH DM-RS remaining in a bundling window after event(s) that violate power consistency and phase continuity requirements] | ENUMERATED {enabled, disable } | in [PUSCH-Config] | [UE-specific] | 38.331 | Working assumption:  If the power consistency and phase continuity are violated due to an event, whether a new actual TDW is created is subject to UE capability of supporting restarting DMRS bundling.  If UE is capable of restarting DM-RS bundling, one new actual TDW is created after the event,  FFS: The start of the new actual TDW is the first available slot/symbol for PUSCH transmission after the event.  If UE is not capable of restarting DM-RS bundling, no new actual TDW is created until the end of the configured TDW. |

Any further comments?

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| **Companies** | **Comments** |
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1. Discussion on RRC parameters for AI 8.8.2
2. Discussion on RRC parameters for AI 8.8.3
3. References
4. R1-2108673, [Post-106-e-Rel17-RRC-08] NR coverage enhancement, Moderator (China Telecom), RAN1#106-e, August 16th – 27th, 2021.
5. R1-2110415, Recommendations for RAN1 RRC Parameter Preparation, Moderator (Ericsson), RAN1#106-e, August 16th – 27th, 2021.
6. R1-2108847, Discussion on joint channel estimation for PUSCH, ZTE, RAN1#106-e, August 16th – 27th, 2021.
7. R1-2108991, Discussion on Joint channel estimation for PUSCH, vivo, RAN1#106-e, August 16th – 27th, 2021.
8. R1-2109509, Considerations on Rel-17 RRC parameters for Coverage Enhancement, Samsung, RAN1#106-e, August 16th – 27th, 2021.
9. R1-2110002, Joint channel estimation for multiple PUSCH transmission, Sharp, RAN1#106-e, August 16th – 27th, 2021.
10. R1-2110124, Joint Channel Estimation for PUSCH, Ericsson, RAN1#106-e, August 16th – 27th, 2021.